FRDA Research Memo

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Root Disease in NSR Lands in the Southern Interior of British Columbia – Project 3.08

INTRODUCTION

The significant role of root disease in creating not satisfactorily restocked (NSR) areas is increasingly recognized. Root disease inoculum left on-site from the previous stand can infect and kill regeneration. Little is known, however, about the long-term impact of a given level of infection in pre-harvest stands and in the subsequent regeneration.

FRDA Project 3.08, conducted by Pathocon Consulting, focussed on developing methods for evaluating root rot hazard. In 1985/86, root disease survey methods for multi-aged, mixed species stands in the interior of British Columbia were developed.

This Memo reports on the second phase of the project in which the distribution and impact of root diseases in both current and NSR lands were studied. The goal was to identify indicators and develop survey methods that can be used to assess root disease hazard.

Two types of methods were evaluated: direct (looking for evidence of root disease on the regeneration) and indirect (such as examining stumps or residuals from the pre-harvest stand).

In the case of armillaria root disease (*Armillaria ostoyae*), the optimum method for assessing root disease hazard is to combine a silviculture survey (if conifers are present on the site) and a vegetation (specifically falsebox, *Paxistima myrsinities*) survey where conifers are absent. For laminated root rot (*Phellinus weirii*), stump surveys were considered most effective.

DISEASES STUDIED

Two root diseases were studied:

1. *Armillaria ostoyae*

This fungus attacks all species of conifers and some hardwood species, causing decline and death of the affected tree. Characteristics are:

- pronounced resin flow at the bole of the tree;
- fan-like, creamy white mycelium beneath and within the bark of the roots and lower bole;
- armillaria mushrooms (or sporophytes) growing from rotted or mycelium-impregnated roots;
- black, stringy rhizomorphs (cords of mycelium) attached to the roots; and
- spongy pocket rot within the roots or butt.

The fan-like mycelium and basal resinosis are the most reliable indicators of armillaria infection.

2. *Phellinus weirii*

This serious pest attacks many species of conifers but not hardwoods. Characteristics are:

- white-to-brown papery mycelium on the surface of roots;
- red staining in the root xylem, often extending into the butt; and
- decay of the xylem, resulting in easily separated, pitted growth rings. The pits are empty or filled with chestnut-brown mycelium.

In most cases, laminar decay is visible in windthrown trees and in trees broken off at ground level. These are the most reliable signs of the disease.

STUDY METHOD

Root disease incidence was studied in 27 NSR and SR (satisfactorily restocked) cutblocks in the Kamloops Forest Region. Most sites were in the ICHmw3 subzone (Thompson Moist Warm Interior Cedar Hemlock variant).

Eighteen sites were examined thoroughly. This entailed a strip survey (3–5% sampling intensity) to determine the extent of root disease on natural and planted conifers. Hardwoods (trees and shrubs), residual conifers and on-site debris and stumps were examined for infection and a sporophore survey was conducted.

Armillaria ostoyae was found attacking young conifer regeneration and some hardwood species on 14 of these young stands. Adjacent stands were also examined and ecological information collected.

A further nine sites were observed in a cursory manner and root disease incidence was determined qualitatively.

CORRELATION OF ROOT DISEASE WITH SITE FACTORS

No correlation was found with the incidence of root disease and the various ecological features studied. Factors included biogeoclimatic classification, successional status, floristic characteristics and soil features (such as drainage, classification, root depth, pH and humus form).

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ROOT DISEASE HAZARD INDICATORS: WHAT'S EFFECTIVE

1. Conifer Regeneration and Residuals

Silviculture surveys can be used to assess the incidence of armillaria root disease, since the disease is visible on plantations as young as 2 years old. This method yields direct yet conservative evidence of the infection level and can be extrapolated to a hazard rating for the site.

However, only mortality for the past 2–3 years can in fact be measured, so this method may need to be combined with others (e.g., assessment of hardwoods or of dead and declining residuals). This is true also if regeneration is absent or sparse.

Since laminated root rot was not evident on trees less than 3 m tall, silviculture surveys can only be used in older plantations or those with a significant number of well-distributed residuals.

2. Hardwood Indicators

Armillaria root disease was found to attack 12 different hardwood species. Falsebox was considered to be the most useful indicator of infection because of its widespread geographic distribution, and because its susceptibility to root disease was similar to that of conifers (Table 1).

TABLE 1. Comparison of conifer and hardwood armillaria root disease surveys

Site	Falsebox density (N/ha)	% Falsebox with armillaria	% Conifers with armillaria: Mean (all species)	% Conifers with armillaria: Mean (infected species)	% Conifers with armillaria: By spp.
1	2733	5.2	2.2	4.9	Pw 8.2 Fd 1.5
2	2175	0.0	0.0	0.0	
3	3307	12.3	14.4	19.3	Cw 11.0 Fd 14.8 Pw 22.2 Sx 29.3

Levels of hardwood infection (established via surveys of falsebox) can be used to predict the expected level of conifer infection. However, hardwood surveys are labour intensive, involving root excavations of infected plants.

Phellinus does not attack hardwoods.

3. Stumps and Debris

Stump and debris surveys are relatively easy to do. Consider, however, a distinction must be made between saprophytic and pathogenic species of Armillaria for proper identification. This method also gives an estimate of incidence at time of harvest, but does not indicate the losses to be expected in the new stand.

Stump surveys are especially useful because silviculture surveys cannot be used in young plantations. However, because surveys of visibly decayed stumps tend to underestimate the disease incidence, survey results must be seen as conservative estimates.

4. Sporophores

Sporophore surveys for armillaria root disease are very quick, but not very dependable. Sporophore production is sporadic (e.g., on two equally infected trees, one may have many sporophores, the other none) and the timing of their appearance in the fall is difficult to predict.

Laminated root rot sporophores are rarely produced, and those that are, are generally inconspicuous.

5. Observations in Adjacent Stands

Examining similar adjacent stands will not alone yield reliable estimates of root disease hazard on a cutblock. It will only indicate potential incidence. Coupling such observations with observations in the cutblock will give a more accurate hazard rating.

Table 2 summarizes the suitability of hazard indicators.

TABLE 2. Suitability of indicators for assessing root disease hazard

Survey method	Age of stand[a]: Pre-harvest	Post-harvest	Post-estab.
For armillaria root disease			
Sporophores	P	P	P
Regeneration	F	G	G
Hardwoods	P	F	G
Residuals	–	P	P
Stumps	F	F	P
For laminated root rot			
Stumps	G	G	G
Windfalls, debris and residuals	G	P	P
Regeneration	–	–	P

[a] Ratings other than "–" assume presence of the indicator (e.g., intact stumps). P = poor; G = good; F = fair.

TREATMENT OPTIONS

Coming up with appropriate treatment recommendations for assessing root disease options is hampered by the current lack of knowledge about root disease behaviour in young, interior stands. Research is needed to answer such questions as what effect a certain level of infection in a young stand will have at rotation age.

Guidelines are available from the forest pathologists in each Forest Region. Please consult regional staff to obtain them.

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